Metrics for Management

Tim Adams
NASA Kennedy Space Center

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Session M17

Selected Slides
For RMA, see pp. 13, 21, & 22

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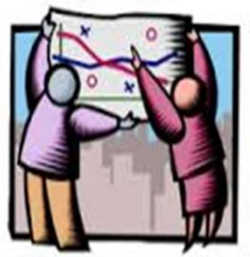
The Global Voice of Quality™

Objectives



- At the conclusion of this session, you should be able to:
  - Answer the "journalistic questions" about metrics for management.
  - Use these answers to identify and build metrics for your organization.

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Who should make the metrics?

- You, the manager!
- Why, because…
- Making (not buying) your own metrics:
  - Provides "expert/information power"
  - Can be revealing…

One reason to do your own metrics

"What is most remarkable is that the mere effort to measure a difficult-to-measure construct can lead to a much deeper understanding and more effective management of that dimension or asset."

Source is Dean Spitzer, author of *Transforming Performance Measurement*, AMACOM, 2007. (Balestracci, D., "Measurement As a Framework for Strategy," Qualitydigest.com, May 08, 2013).

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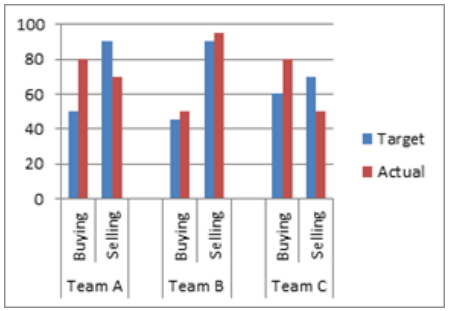
Where should metrics be used?

- Metrics are <u>needed</u>:
  - With imperfect systems.
  - When desired state is critical.
  - When management has a high desire to obtain the desired state.
- Metrics are <u>not needed</u>
  - With perfect or low-risk systems.

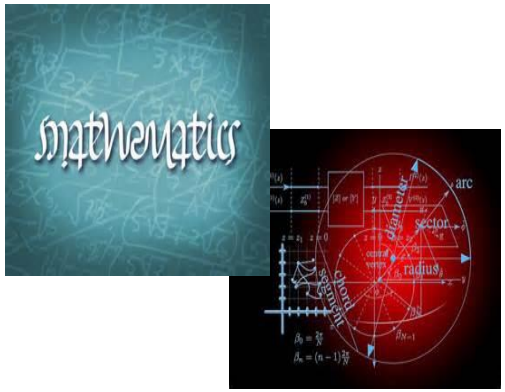
Why do metrics?

- To quantitatively characterize the performance gap and to support the decision to…
  - Continue as is,
  - Make adjustments (changes), or
  - Obtain more information to make a risk-informed decision.

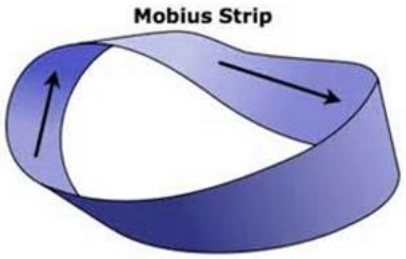


Mathematical view of a metric

- In Mathematics, a **metric** is an abstraction of the **notion of distance**.

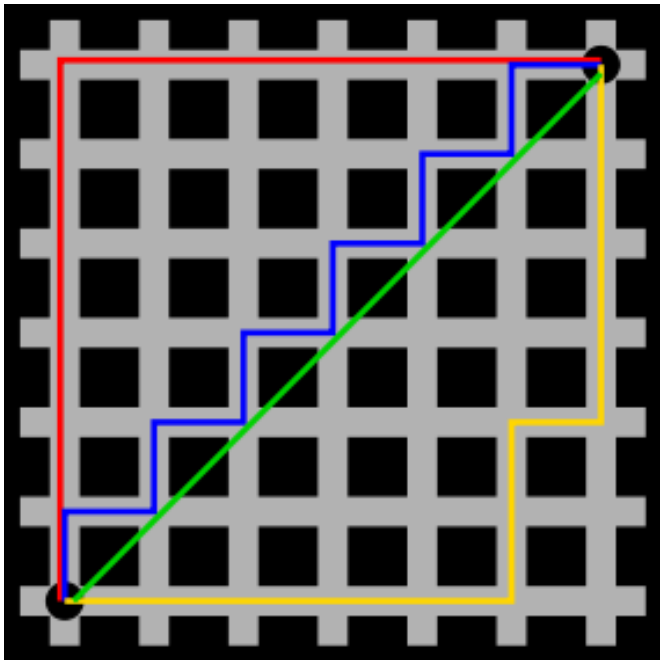


- Not all topologies have a metric space, and not all metric spaces measure distance the same way.



Same 2 points, but different metrics

- In Euclidean geometry, a straight line is the shortest distance between two points.
- In Minkowski (Taxicab) geometry, length uses a different **metric** or **distance function**.



1-norm distance $= \sum_{i=1}^{n} |x_i - y_i|$

2-norm distance $= \left(\sum_{i=1}^{n} |x_i - y_i|^2 \right)^{1/2}$

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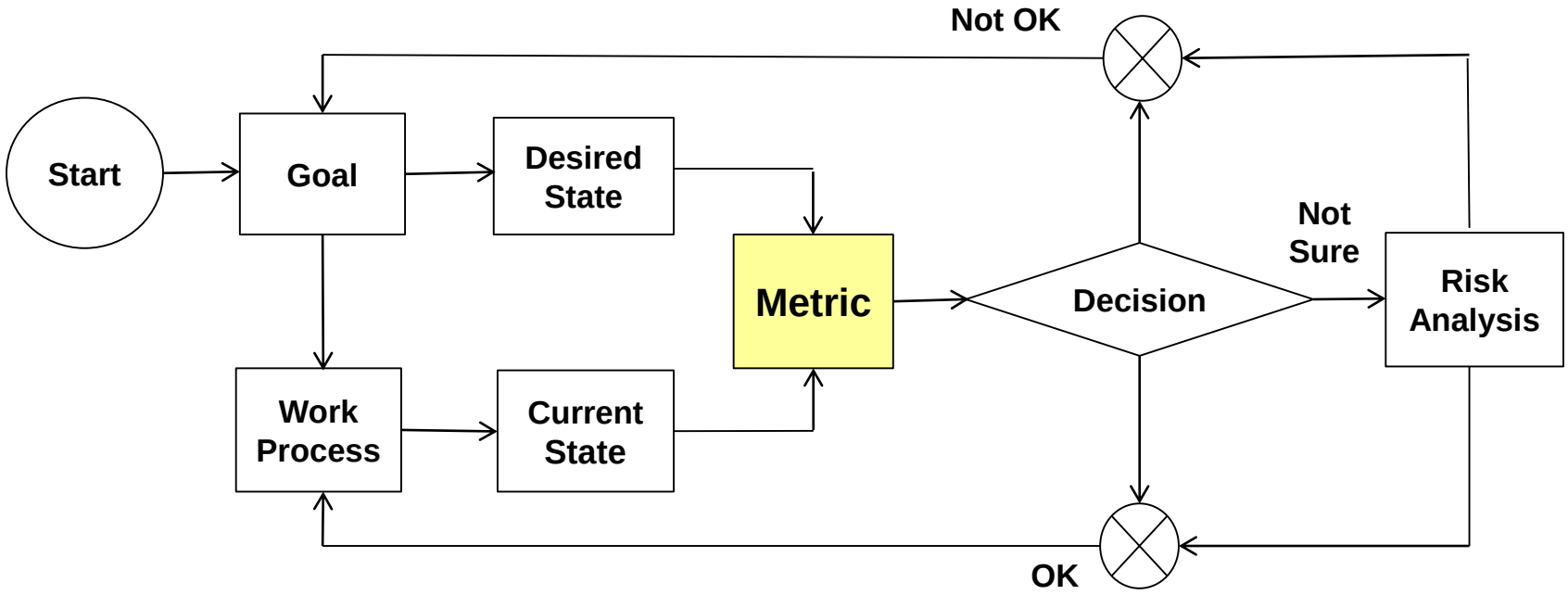
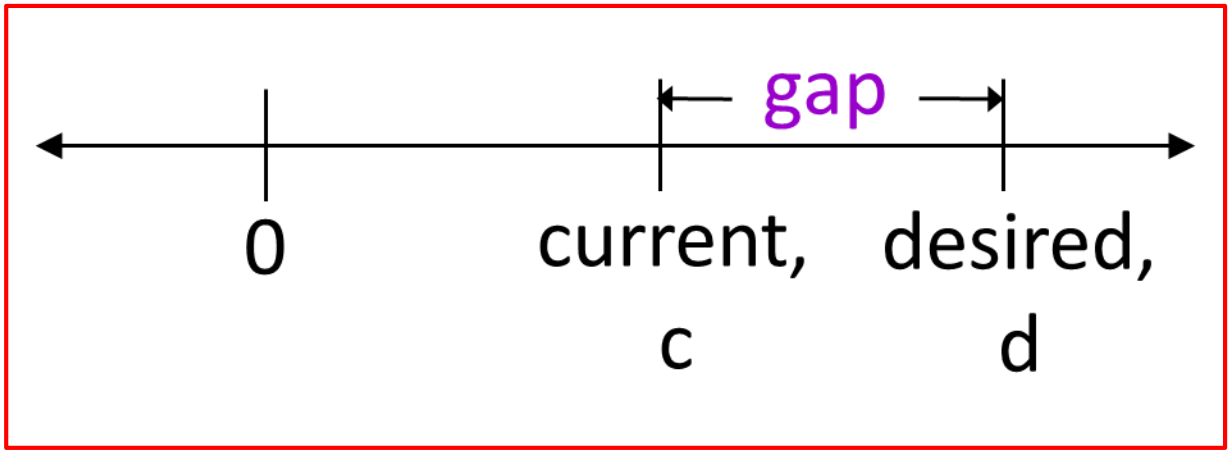
Management metric – flow diagram



- A **management metric** assigns a measure to the **performance gap**.

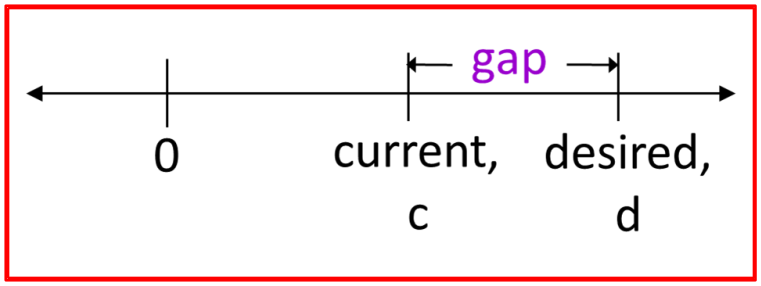
Management metric – definition

- A **mathematical function** that assigns a measure to the "gap" between the output's current state (**c**) and the goal's desired state (**d**).



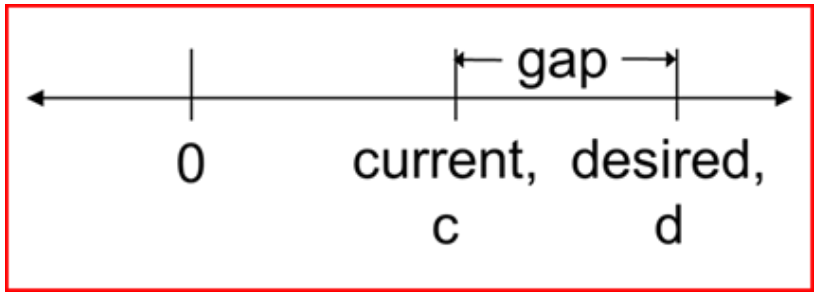
Math for Metrics – getting started

- Distance functions or metrics could use:
  - **d – c**, **c – d**, or **c/d**.



  - Order does not change the magnitude or absolute value of the difference.
  - **Absolute value** of a number is the number without its sign and is denoted |x|. That is, |-x| = x.
  - In Microsoft Excel, use the **ABS** function.
  - Use c/d since d is the reference state.
  - Do not use **d/c** since **d/c** ≠ **c/d**.

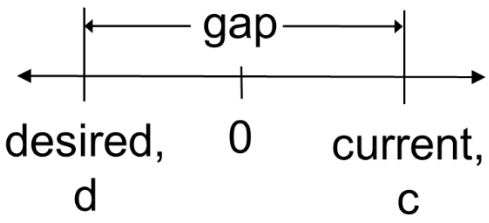
…or could use these formulas



- **Absolute Error**
  - $\Delta_{AE} = |d - c|$.
- **Relative Error**
  - $\Delta_{RE} = |(d - c)/d|$ where $d \neq 0$.
- **Relative Change**
  - $\Delta_{RC} = (c - d)/|d|$ where $d \neq 0$.

Observations about the math

- $\Delta_{AE} / |d| = \Delta_{RE}$ where $d \neq 0$.
- Δ_{RE} and Δ_{RC} yield the same unsigned number.
- Δ_{RC} gives direction (+ or -) regardless if $d < 0$ or $d > 0$.
- Δ_{AE}, Δ_{RE}, and Δ_{RC} approach zero as **c** approaches **d**.
- Δ_{RE} and Δ_{RC} are dimensionless; Δ_{AE} has a dimension. Thus …
- **c** and **d** must have the same units of measurement.



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“Objective” metrics – 3 types

1. **Effectiveness** (~ Quality)
   - How well results accomplished the stated purpose.
2. **Efficiency** (~ Quantity)
   - How well resources were used or consumed.
3. **Appeal** (~ Acceptance)
   - How well human preference was satisfied.

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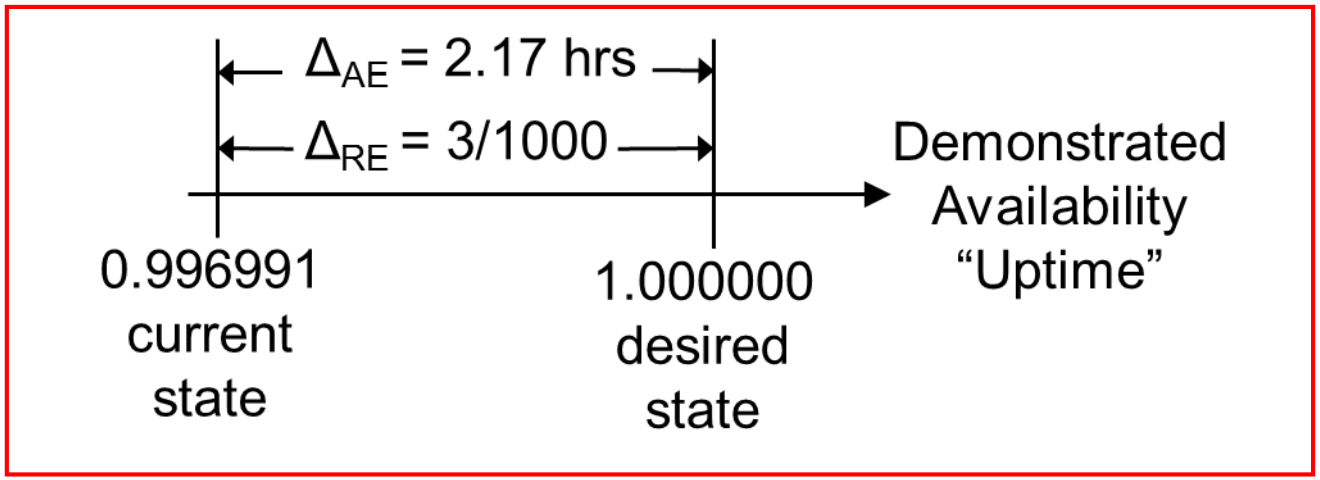
Example – effectiveness metric

- A 24-hour service was not available for 2 hours 10 minutes in a 30-day period.
- Conforming = Total - Nonconforming.
- $\Delta_{RE} = |1 - (30*24 - 2^{10}/_{60})/(30*24)| =$ $1 - 0.996991 = 3.009 \times 10^{-3} \approx$ **3/1000**.



Example – efficiency metric

- Desired (plan): Use $0.075 per mile since hybrid fleet averages 40 mpg and fuel cost is $2.40 per gallon plus 25% margin.
- Current (actual): The fleet billed $12,000 for 140,000 miles or $0.086 per mile.
- Δ_{RC} = (0.086 - 0.075)/|0.075| = 0.011/|0.075| = **+14.6%**. Thus, the cost for fuel currently exceeds plan for the reporting period.

Example (use $\mathbf{d^c}$ when **d = 0**)

- **Given**

  d = No problems.

  c = 3 defects in 1000 items.

- **Metric using failure-space inputs**

  Δ_{AE} = |0 - 3| = |-3| = **3** defects.

  Δ_{RE} = |1 - 3/0| = **?**. Instead, try ...

- **Metric using success-space inputs**

  Δ_{AE} = |1000 - (1000 - 3)| = |+3| = **3** def.

  Δ_{RE} = |1 - (1000 - 3)/1000| = **3/1000**.

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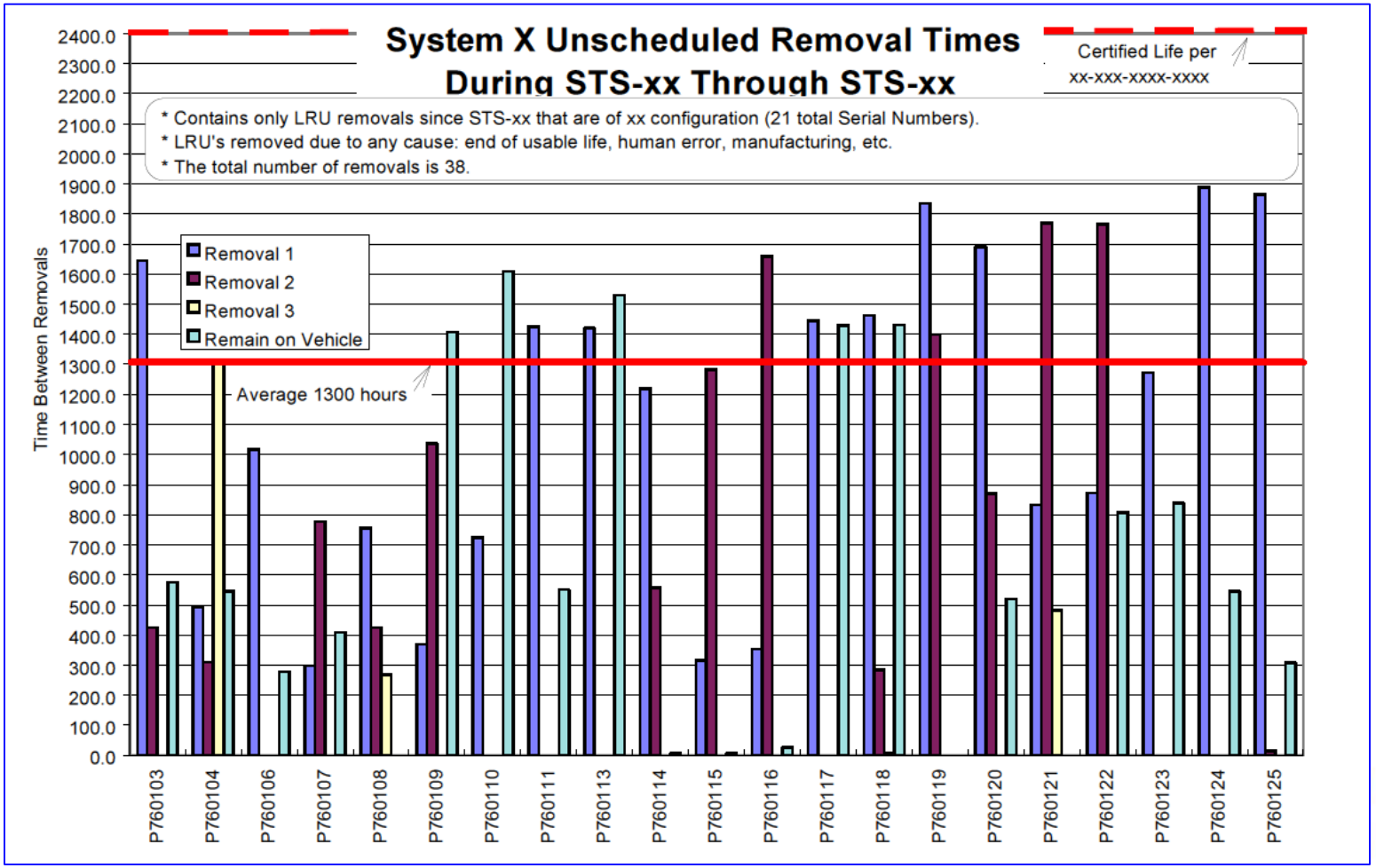
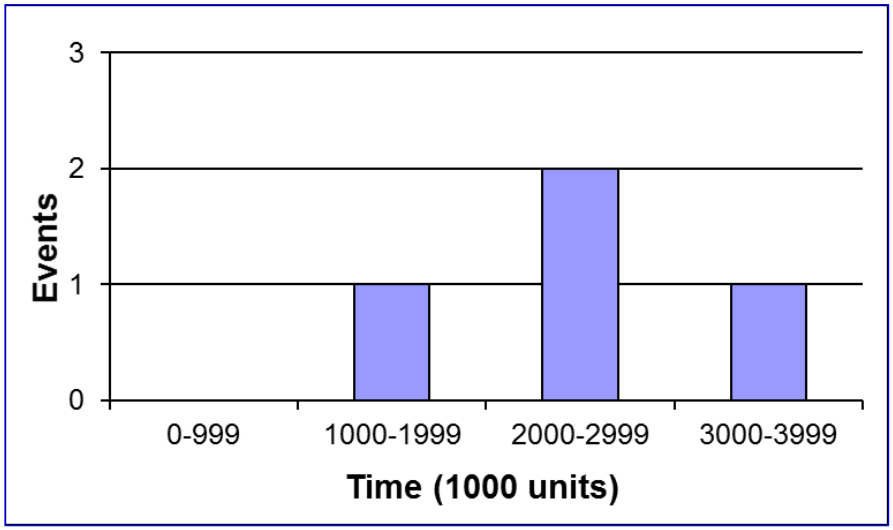
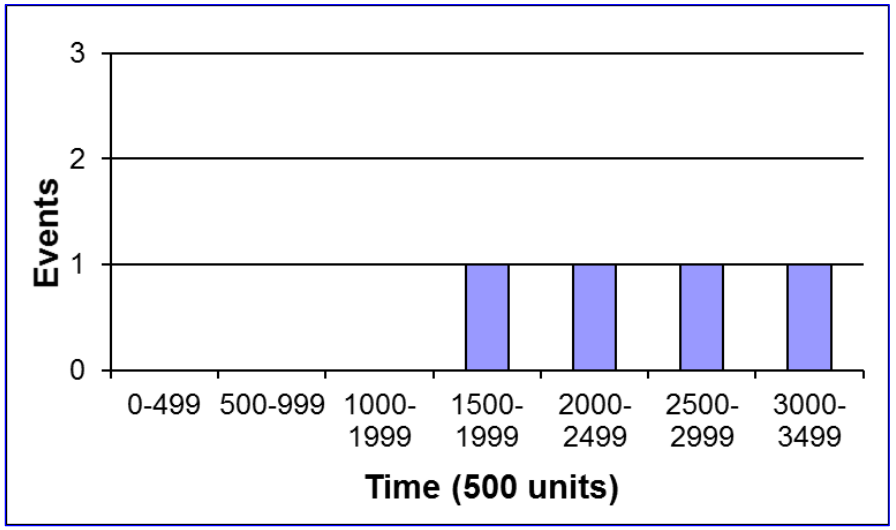
Great graph; why metric formulas?

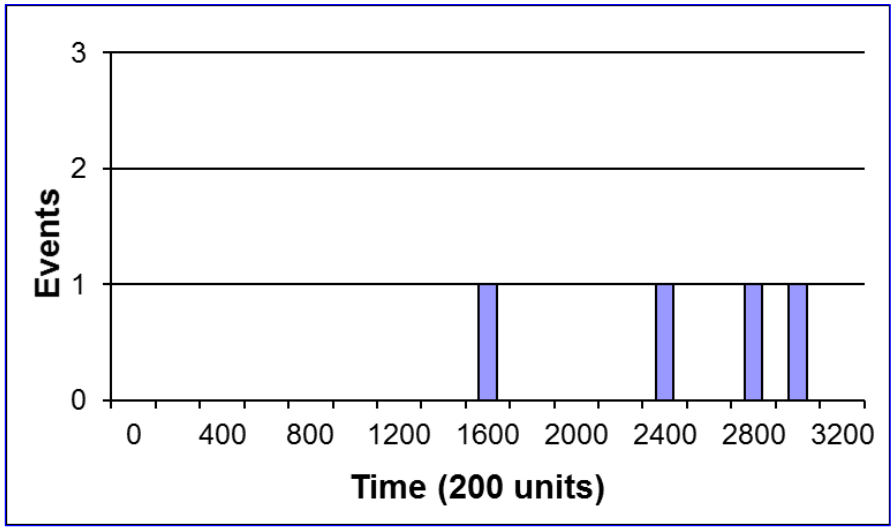
Desired state = 2400 hr; Avg current state = 1300 hr)



Example What is the trend? (**d = ?**)







Trending without graphs

- All graphs used the same data!
- To test for a trend in discrete events without graphing, use the **Laplace Test**, a test statistic.

$$z = \left[\left(\left(\sum_{i}^{n} t_i\right)/n\right) - T/2\right] \Big/ T\sqrt{1/(12n)}$$

- t_i is the time from the start time to the time of the i^{th} event.
- n is the number of events.
- T is the time from the start time to the end time of the observation period.

Graphs instead of metric formulas?

- Sometimes a picture is worth a 1000 words, and sometimes it can be misleading or confusing.
- When there is sufficient amount of data, do both:
  - Plot the data
  - Treat the data.

Types of effectiveness

- **Technical characteristics**

  Physical characteristics (e.g., size, shape) and functional capability.
  "On the drawing."

- **Operating characteristics**

  Non-physical characteristics being operating behaviors and outcomes (examples on next page).
  "Inferred by the drawing."

Operating outcomes & behaviors

Safety: Freedom from accident and loss	**Usability**: Human interfaces	**Supportability and Serviceability**: Service throughout the planned life cycle
Reliability: Likelihood of having an uptime (failure-free) state for a stated duration or load	**Maintainability**: Likelihood of returning to an uptime state due to maintenance or repair	**Availability**: Likelihood a repairable item has an uptime state; **A** = f (**R**, **M**)
Producibility: Ease and economy of producing or manufacturing	**Affordability**: Total cost of ownership and not only system acquisition cost	**Disposability**: Disassembly and disposal (environmental stewardship)

Example Pick one: “I need you to be…”

1. Effective
   - Complete task “x” with no errors.
2. Efficient
   - Produce “y” units per hour, cost.
3. Appealing
   - Check your work, support last minute changes, be team oriented, be safe...

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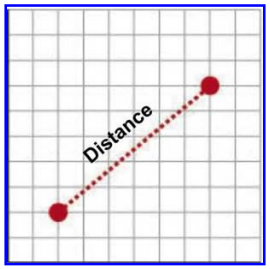
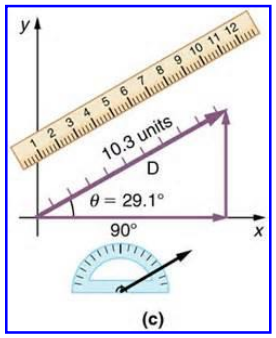
How many metrics are needed?

- As the previous example illustrated …
  - Performance is seldom if ever assessed by a single metric.
- Consider a **dashboard**, a combination of metrics, for your organization.

Benchmarking: Do your metrics …

- Measure distance or length?
  - **Distance** is between two points.
  - For management, the two states are:
    - What you want, and
    - What you have.
  - **Length** is a measure from zero.
    - It does not compare states.
    - It only measures one state.





Benchmarking: Do your metrics …

- Focus on what should be measured, and not what can be measured?

- Objectively measure all areas of organizational performance?
  - Effectiveness,
  - Efficiency, and
  - Human Appeal?

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A management metric is not a…

- Statistic, a function of the sample data.
- Trend when it uses length (not distance).
- Figure of merit, aggregated quantities used to characterize performance and options.
- Risk measure, Prob. of Failure x Impact.
- Any single count or measure or just lengths.

Why? Because a **metric** is a function of two points (states) and not one.

Contact Information

Timothy C. Adams
Senior Engineer, Reliability
NASA Kennedy Space Center
Engineering & Technology Directorate
Technical Performance & Integration Division
Tim.Adams@NASA.gov
321-867-2267


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